DESCRIPTION

FIBER MATERIALS HAVING IMPROVED QUALITIES REQUIRED FOR CLOTHES AND METHOD OF IMPROVING THE SAME

FIELD OF THE INVENTION

[0001] The present invention relates to fiber materials having texture characteristics of a natural fiber and whose qualities required for clothes have been improved, and a method of improving the same. More specifically, the present invention relates to fiber materials (for example, yarns, or knitted goods or woven goods made of yarn) that are made from a natural fiber and a chemical fiber containing titanium oxide.

BACKGROUND OF THE INVENTION

[0002] Knitted goods or woven goods including underwear, outerwear and socks, which use mainly a natural fiber such as silk or the like are excellent in terms of texture aspects such as appearance and feel against the skin. Conversely, such goods also include drawbacks such as the tendency to yellow due to the effects of light or sweat. Therefore, various measures have been tried in the past in order to overcome such drawbacks. For example, Japanese Patent Laid-Open Publication No. HEI 6-141739 discloses a method for preventing yellowing of raw silk and silk characterized by bringing raw silk or silk with a compound selected from the group consisting of deoxycytidylic acid and cytidylic acid, in order to produce raw silk and silk that hardly yellows due to sunrays or ultraviolet rays. As other art, Japanese Patent Laid-Open Publication No. 2001-172835 discloses lightfast yarn and a lightfast fiber product using the lightfast yarn as a portion of its material, which are characterized by spinning with combining an artificial fiber containing a far infrared light-radiating material with a silk fiber. Furthermore, disclosed in WO No. 98/53132 is a silk fiber containing titanium oxide whose surface is plated with titanium oxide. Deterioration and yellowing of the silk fiber is described as not occurring due to the photo-catalytic action of titanium oxide.

[0003] However, there are some unsolved problems requiring attention that remain in the inventions described in the above publications, examples of which are as follows. By including an ultraviolet absorbent such as deoxycytidylic acid and cytidylic acid in the silk itself as disclosed in Japanese Patent Laid-Open Publication No. HEI 6-141739, there is a risk that while the light fastness of the silk is improved

and yellowing is prevented, conversely, the quality of the silk may deteriorate and texture aspects such as the appearance and feel of the silk against the skin may also be affected. Moreover, due to the fact that it is relatively difficult and costly to obtain the far infrared light-radiating material, issues such as high production cost, as well as practical and general application all remain for a fiber product mixed with such material according to Japanese Patent Laid-Open Publication No. 2001-172835. Furthermore, according to WO No. 98/53132, there is a possibility that titanium oxide plated on the surface of the silk fiber may fall off relatively easily due to bodily contact or the effects of sweat, thereby lowering the effect of yellowing suppression. Therefore, it is hardly appropriate for use as a product material in direct contact with the skin, such as underwear or socks. Since titanium oxide is plated to the surface of the silk fiber, there is also a risk that texture aspects such as the appearance and feel against the skin characteristic of the silk fiber may be worsened due to the titanium oxide on the surface. Additionally, when processed into conventional clothes using mainly a natural fiber, unused products not yet worn among the clothes made meet the qualities required for clothes to a certain extent with regards to warmth retention, strength, etc. However, once the clothes become worn repeatedly, the above-mentioned qualities required for clothes are gradually lowered or lost due to the effects of heat, light, water, weather, or the like. With clothes that develop a strong odor such as an ammonia smell in the course of wear, for example, the odor can often not be easily removed through washing or the like. In particular, substances that cause illnesses related to sick house, such as formaldehyde, which adhere to and remain in clothes over time cause that much more suffering in a patient afflicted with such an illness. Accordingly, in order to increase the product value and product life of clothes, it is necessary and called for that fiber materials having qualities required for clothes which are used therein be improved.

[0004] The present invention was devised to address such requirements, and it is an object of the present invention to provide fiber materials (for example, yarns, knitted goods and woven goods) which sustain texture characteristics of a natural fiber such as silk, are effectively prevented from yellowing over time due to light or sweat, are less contaminated with a residual toxic gas, and are effectively prevented from worsening in warmth retention and strength over time, but which can be produced at a lower cost.

DISCLOSURE OF THE INVENTION

[0005] The present invention relates to fiber materials having improved qualities required for clothes, characterized by comprising a chemical fiber containing titanium oxide; and a natural fiber, wherein both the fibers exist in a state of mutual contact.

[0006] A preferable form among such fiber materials relates to the fiber materials having improved qualities required for clothes that are yarn made by spinning the chemical fiber containing titanium oxide and the natural fiber.

[0007] The present invention also relates to the fiber materials having improved qualities required for clothes, characterized in that the fiber materials are composite yarn made by winding sheath yarn comprising the natural fiber around an outer surface of core yarn comprising the chemical fiber containing titanium oxide.

[0008] Another form of the present invention relates to the fiber materials having improved qualities required for clothes, characterized in that the sheath yarn of the composite yarn is wound around the core yarn in a state where the core yarn is not exposed in practical terms.

[0009] The present invention also relates to the fiber materials having improved qualities required for clothes, wherein the fiber materials are twisted yarn made by mutually twisting together yarn comprising the chemical fiber containing titanium oxide and yarn comprising the natural fiber.

[0010] The present invention also relates to the fiber materials having improved qualities required for clothes, wherein the fiber materials are fabric or knitted goods woven or knitted using at least the above yarn, the above composite yarn, or the above twisted yarn in at least a portion of yarn structuring cloth.

[0011] A preferable form of the present invention relates to the fiber materials having improved qualities required for clothes, wherein the fiber materials are fabric made using the yarn comprising the chemical fiber containing titanium oxide as a warp and/or a weft of an intermediate material of the fabric, and then incorporating the yarn comprising the natural fiber in the intermediate material from above and below so as to cover and hide the intermediate material.

[0012] Another form of the present invention relates to the fiber materials having improved qualities required for clothes, wherein the fiber materials are sandwich-structured cloth comprising a cloth woven using the yarn with the chemical fiber containing titanium oxide and a cloth woven using the yarn with the natural fiber, which is overlaid and connected on both top and bottom sides thereof.

[0013] A preferable form of the present invention relates to the fiber materials having improved qualities required for clothes, wherein the chemical fiber includes 0.01 to 5.0% by weight of titanium oxide based upon the total fiber weight.

[0014] In particular, the present invention relates to the fiber materials having improved qualities required for clothes, wherein the natural fiber is silk.

[0015] Moreover, the present invention relates to the fiber materials having improved qualities required for clothes, wherein the chemical fiber is at least one type of fiber selected from the group consisting of synthetic fibers such as polyester fiber, polyamide fiber (nylon fiber), polypropylene fiber, polyethylene fiber, polypro mix fiber, and polychlal fiber, as well as regenerated fibers such as viscose fiber and cuprammonium rayon, and semi-synthetic fibers such as acetate fiber.

[0016] Another form of the present invention also relates to a method for improving qualities required for clothes in fiber materials by structuring the fiber materials from a chemical fiber containing titanium oxide and a natural fiber, wherein both the fibers exist in a state of mutual contact.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] FIG. 1 is a drawing showing yarn according to the present invention that is made by spinning a chemical fiber containing titanium oxide and a natural fiber;

FIG. 2 is a drawing showing composite yarn according to the present invention that is made by winding sheath yarn comprising the natural fiber on an outer surface of core yarn comprising the chemical fiber containing titanium oxide;

FIG. 3 is a drawing showing twisted yarn according to the present invention that is made by mutually twisting together the yarn comprising the natural fiber and the yarn comprising the chemical fiber containing titanium oxide;

FIG. 4 is a drawing showing a plain-woven fabric according to the present invention, which is a form of fiber materials having improved qualities required for clothes;

FIG. 5 is a drawing showing a form of fabric according to the present invention that is made by using the yarn comprising the chemical fiber containing titanium oxide in a warp of an intermediate material of the fabric, and incorporating the yarn comprising a silk fiber upwards and downwards in the intermediate material so as to cover and hide the intermediate material;

FIG. 6 is a drawing showing a form of cloth comprising a cloth woven using the yarn with the chemical fiber containing titanium oxide and the yarn with the silk fiber, which is overlaid and connected on a top side thereof; and

FIG. 7 is a drawing showing a form of sandwich-structured cloth comprising the cloth woven using the yarn with the chemical fiber containing titanium oxide and the cloth woven using the yarn with the silk fiber, which is overlaid and connected on both top and bottom sides thereof.

BEST MODE FOR CARRYING OUT THE INVENTION

[0018] According to the present invention, qualities required for clothes denote qualities required for types of clothing, such as outerwear, underwear and socks made from fiber materials such as yarn, which should be maintained, and for example, include the following qualities: prevention from yellowing over time; no generation of residual adsorbed odor or harmful substances that cause allergies; excellent warmth retention in addition to having physical characteristics such as a predetermined strength and elasticity, and hardly tears; easy conformance to body shape and movement, with abundant stretch; and excellent breathability.

[0019] In order to achieve fiber materials according to the present invention having texture characteristics of a natural fiber and with more improved qualities required for clothes as described above, a chemical fiber containing titanium oxide and the natural fiber must be used. Moreover, it is sufficient to create a form in which both the fibers mutually contact. One form is given in FIG. 1, where yarn 3 is shown made by spinning plural chemical fibers 1 containing titanium oxide and plural natural fibers 2, preferably silk. Creating a form in which the chemical fiber 1 and the natural fiber 2 of varying lengths exist substantially uniform overall in mutual contact results in effective prevention of yellowing over time due to light or sweat, less contamination with a residual toxic gas, and effective prevention of worsening in warmth retention and strength over time. Furthermore, the yarn 3 overall takes on the texture characteristics of the natural fiber 2. The chemical fiber 1 and the natural fiber 2 are capable of maintaining the improved qualities required for clothes in the yarn 3 structured therewith, and are also capable of being spun in respective predetermined proportions within a range that does not significantly worsen the texture characteristics of the natural fiber 2.

[0020] A more preferable form of the fiber materials according to the present invention is composite yarn 6 shown in FIG. 2 that is achieved by winding sheath yarn 5 comprising the natural fiber around an outer surface of core yarn 4 comprising the chemical fiber containing titanium oxide. Since the core yarn 4 contacts the sheath yarn 5 and the surface of the core yarn 4 is completely covered thereby, the composite yarn 6 is a highly preferable form that has a texture exceedingly close to the sheath yarn 5 comprising the natural fiber, in addition to having improved qualities required for clothes. Moreover, the sheath yarn 5 need only be wound around the core yarn 4 such that the core yarn 4 is not exposed in practical terms. For example, the composite yarn 6 may be a form in which the sheath yarn 5 is wound such that the core yarn 4 is not exposed, or the composite yarn 6 may be a form in which the sheath yarn 5 is wound such that the core yarn 4 is exposed within a range that does not excessively worsen the texture characteristic of the sheath yarn 5 comprising the natural fiber. Not having the core yarn exposed in practical terms includes a state in which the core yarn is completely unexposed, as well as states in which the core yarn is exposed at one portion or a plurality of portions of the composite yarn.

[0021] In addition, twisted yarn made by twisting together the yarn comprising the chemical fiber containing titanium oxide and the yarn comprising the natural fiber is another example of the fiber materials according to the present invention that are yarn. As shown in FIG. 3, for example, yarn 7 comprising a nylon fiber containing titanium oxide and yarn 8 comprising a silk fiber are twisted together to achieve mutual contact. Therefore, the twisted yarn made has improved qualities required for clothes, as well as a texture resembling the texture of the natural fiber used.

[0022] The fiber materials that are yarn of the present invention described heretofore may also be a form structured from the chemical fiber containing titanium oxide and the natural fiber combined with single types, respectively, e.g., the nylon fiber containing titanium oxide and silk. Alternatively, such fiber materials may also be a form structured from a plurality of predetermined types, e.g., a combination of the nylon fiber containing titanium oxide, polyester fiber and silk. Furthermore, the composite yarn or twisted yarn according to the present invention may be used as sheath yarn or core yarn to make another composite yarn, and the composite yarn or twisted yarn according to the present invention may also be used to make another twisted yarn.

[0023] Another form of the fiber materials according to the present invention having improved qualities required for clothes is a fabric that is woven using yarn, composite yarn or twisted yarn made by spinning the chemical fiber containing titanium oxide and the natural fiber (hereinafter abbreviated to "yarn containing titanium oxide" in this specification), for at least a portion of the yarn structuring the cloth, or knitted goods that are knitted using such yarn containing titanium oxide. As an example in FIG. 4 shows, the fabric uses the yarn containing titanium oxide as a warp 10 and/or a weft 11, which achieves a plain-woven fabric (a fabric 12) by mutual intersections over and under each yarn. In this case, other types of yarn in addition to the yarn containing titanium oxide may be used for the warp 10 and the weft 11, provided that the fabric made has improved qualities required for clothes, and the texture of the natural fiber is within a range that is not greatly worsened. Some possible examples include: a form that uses yarn containing titanium oxide for all the warp 10 and the weft 11; a form that uses silk for all the warp 10, and the yarn containing titanium oxide (twisted yarn) for all the weft 11; and a form that for all the warp 10 uses an appropriate ratio of the yarn containing titanium oxide, with the silk yarn being used for the remaining proportion of the warp 10, and for all the weft 11 using the silk yarn, the yarn containing titanium oxide, or both the silk yarn and the yarn containing titanium oxide. An arbitrary weave may be used for the fabric according to the present invention, which can also be obtained as a plain weave, as well as twill weave, satin weave, figured weave, leno weave, two-ply weave, or pile weave.

[0024] An even more preferable form of fabric according to the present invention is a fabric made using the yarn comprising the chemical fiber containing titanium oxide as the warp and/or weft of the intermediate material of the fabric, and then incorporating the yarn comprising the natural fiber in the intermediate material from above and below so as to cover and hide the intermediate material. For example, a fabric 13 shown in FIG. 5 is made using yarn 14 comprising the chemical fiber containing titanium oxide as the warp of the intermediate material, and contacting yarn 15 and yarn 15' comprising the natural fiber (the silk fiber) so as to hide and cover the warp 14 of the intermediate material from above and below. Accordingly, the fabric 13 has improved qualities required for clothes, and has texture aspects such as appearance and feel against the skin that are identical to a fabric that is woven from a single natural fiber. In particular, such fabric is suitable as a material for products

that come in direct contact with the skin, such as underclothing and socks. Moreover, this is naturally achieved regardless of whether the yarn 15 and 15' comprising the natural fiber are of the same or different types.

[0025] In addition, for knitted goods of the present invention having improved qualities required for clothes, the knitting method is arbitrary and either hand knitting or machine knitting, for instance, may be used to obtain such knitted goods through the following: a plain stitch (stocking stitch, sheeting knit), a rib stitch (cardigan stitch), pearl stitch (garter stitch), tuck stitch, float stitch, half cardigan stitch, interlock stitch, lace stitch, plating stitch, pile stitch, denbigh stitch (tricot stitch), Van Dyke (atlas) stitch, plain cord stitch, two needle stitch, pelerine stitch, double denbigh stitch, double Van Dyke stitch, milanese stitch, raschel knit, fleece knit, and jacquard stitch.

[0026] FIG. 6 shows another form of the fiber materials according to the present invention having improved qualities required for clothes, where a cloth 18 comprises a cloth 16 woven using the yarn with the chemical fiber containing titanium oxide and a cloth 17 woven using the yarn with the silk fiber, which is overlaid and connected on a top side thereof. The cloth 18 is a form in which the cloth 17 is vertically and horizontally sewn (broken lines in the figure) and connected only on either the top or bottom side of the cloth 16 using silk yarn 19.

[0027] Another preferred form of the fiber materials according to the present invention is a sandwich-structured cloth 22 shown in FIG. 7 comprising a cloth 20 woven using the yarn with the chemical fiber containing titanium oxide and a cloth 21 woven using the yarn with the silk fiber, which is overlaid and connected on both top and bottom sides thereof. In the structured cloth 22, the cloths 21 and 21 are in contact with the cloth 20 in a state where the cloth 20 is sandwiched between the cloths 21 and 21. Thus from the standpoint of the overall sandwich-structured cloth 22, not only does it have improved qualities required for clothes, but texture aspects such as appearance and feel against the skin are also identical to the cloth 21. In FIG. 7, the cloths 20, 21 are connected through vertical and horizontal sewing (broken lines in the figure) using the silk yarn 19; however, yarn other than silk may naturally be used and other connecting means may be selected as appropriate.

[0028] A form of titanium oxide used in the present invention for improving the fiber materials' qualities required for clothes is preferably a powder form whose average particle diameter is 0.5 μm or less. If the particle diameter exceeds 0.5 μm,

the yarn comprising the chemical fiber containing the titanium oxide becomes prone to break. Based upon the total fiber weight, the chemical fiber generally contains 0.01 to 5.0% by weight of titanium oxide. If there is less than 0.01% by weight, the fiber materials' qualities required for clothes obtained thereby are not effectively improved. Conversely, more than 5.0% by weight is not preferable, because the fiber materials' qualities required for clothes do not improve any further. Moreover, the yarn becomes prone to breaking in the spinning and stretching processes for the chemical fiber, in addition to an increased risk of friction damage from the rollers, guides, etc. of the spinning machines, knitting machines and looms. The inclusion amount of titanium oxide is preferably 0.1 to 1.0% by weight based upon the total fiber weight in consideration of the balance between improving the effect of the fiber materials' qualities required for clothes and prevention of the yarn breakage mentioned above. Additionally, the chemical fiber containing titanium oxide can be manufactured by wet spinning, dry spinning, or melt spinning as appropriate, for example, by melting a polymer serving as a base, directly mixing titanium oxide therewith, and then spinning.

[0029] A suitable natural fiber used in the present invention may be, for example, silk, cotton, animal hair (wool, cashmere, vicuna, alpaca, angora, mohair, camel, etc.), flax, and paper. For the chemical fiber, suitable examples include synthetic fibers such as polyester fiber, polyamide fiber (nylon fiber), polypropylene fiber, polyethylene fiber, polypro mix fiber, and polychlal fiber, as well as regenerated fibers such as viscose fiber and cuprammonium rayon, and semi-synthetic fibers such as acetate fiber.

[0030] As described above, the fiber materials having improved qualities required for clothes according to the present invention comprise a chemical fiber containing titanium oxide and a natural fiber, and include yarn, for example, or knitted goods and woven goods using the yarn. Such fiber materials have a form in which the natural fiber is constantly in contact with the chemical fiber containing titanium oxide, regardless of the natural fiber being used. Therefore, effective prevention of yellowing over time due to light or sweat can be achieved. Regarding clothes made from the fiber materials according to the present invention, such clothes excel in the sustained release of toxic gas over a long period. For example, even if a gas with a strong odor or a gas hazardous to humans is adsorbed, the adsorbed gas is released in a sustained manner at an extremely high rate into environments previously without

such gas. Therefore, it is possible to effectively avoid a state where hazardous gas, which is a cause of strong odor or an illness related to sick house, is constantly adsorbed by the clothes. Furthermore, a cloth comprising the fiber materials of the present invention excel more in warmth retention over long periods of use compared to a cloth structured from all silk fiber, in addition to excellent durability in terms of strength. Accordingly, clothes can be manufactured which are thinner and lighter than conventional products, but have the same warmth retention and strength. The fiber materials of the present invention also have properties closely resembling texture aspects of fiber materials comprising all natural fiber such as appearance and feel against the skin. Furthermore, on the production side as well, titanium oxide is easy to obtain at low cost, and the inclusion of titanium oxide in the chemical fiber can be easily achieved. This in turn has the advantage of suppressing the production cost of the fiber materials, making it advantageous in terms of productivity as well.

[0031] Hereinafter, the present invention will be described in further concrete detail using test examples; however, the present invention is not particularly limited thereby.

(Test Example 1) Yellowing Tests

[0032] The degree of yellowing due to light and sweat of a fabric that is a fiber material according to the present invention was weighed against the degree of yellowing due to light and sweat of a fabric comprising all natural fiber.

[0033] Sample A: 1.0% by weight of titanium oxide (average particle diameter: 0.1 μm) was added to 100% by weight of melted nylon-6 polymer and mixed until uniform. This melted solution was subsequently passed through a spinning machine and spun to obtain yarn containing titanium oxide. Fabric according to the present invention serving as sample A was then plain woven using composite yarn that was obtained by winding silk yarn as the sheath yarn around the yarn containing titanium oxide, which served as the core yarn.

[0034] Sample B: Fabric according to the present invention serving as sample B and shown in FIG. 4 was obtained through plain weaving using the yarn containing titanium oxide, which was obtained by a method identical to the first embodiment, as the warp 10 shown in FIG. 4, and using the silk yarn similarly used in the first embodiment as the weft 11 shown in FIG. 4.

[0035] Sample C: Fabric according to the present invention serving as sample C was obtained through an operation similar to the first embodiment, but which used a hair fiber comprising wool as the sheath yarn.

[0036] Sample D: Fabric according to the present invention serving as sample D was obtained through an operation similar to the first embodiment, but which used cotton yarn comprising cotton as the sheath yarn.

[0037] Sample E: Fabric according to the present invention serving as sample E was obtained through plain weaving silk yarn similar to that used in the first embodiment.

[0038] Sample F: 0.005% by weight of titanium oxide (average particle diameter: 0.1 μm) was added to 100% by weight of melted nylon-6 polymer and mixed until uniform. This melted solution was subsequently passed through a spinning machine and spun to obtain yarn containing titanium oxide. Fabric serving as sample F was then plain woven using composite yarn that was obtained by winding silk yarn as the sheath yarn around the yarn containing titanium oxide, which served as the core yarn.

[0039] Comparative example: 8.0% by weight of titanium oxide (average particle diameter: 0.1 μm) was added to 100% by weight of melted nylon-6 polymer and mixed until uniform. This melted solution was subsequently passed through a spinning machine and spun. However, the spinning process and subsequent stretching process were aborted due to excessive yarn breakage and difficulty in obtaining yarn of the desired thickness.

[0040] A color fastness test was performed on the obtained samples A, B, C, D, E, and F. It should be noted that the light resistance test as specified below was performed in accordance with JIS L0842 (test with carbon arc lamp light), and the perspiration resistance test (acidic and alkaline) were performed in accordance with JIS L0848.

Method of JIS L0842 (test with carbon arc lamp light)

[0041] Samples A, B, C, D, E, F and a blue scale were each placed between thick pieces of paper, and attached to test holders of the machine for testing color fastness to carbon arc lamp light. Next, the test holders were attached so as to leave no clearance with a test specimen rotating device, and were then exposed to light in accordance with Section 6-(1) (first light exposure method) of JIS L0841. A determination was made in accordance with Section 9 (color fastness determination) of JIS L0801.

Method of JIS L0848 (perspiration resistance test)

[0042] Samples A, B, C, D, E, and F were each cut into test pieces 100 × 40 mm in size. These test pieces were placed between two standard adjacent fabrics as specified

in JIS L0803 and then sewn together on two sides to create composite test pieces. Thereafter, the composite test pieces were each pressed and moved around in two beakers containing acidic artificial perspiration and alkaline artificial perspiration, respectively, to allow sufficient and uniform saturation of the test fluids. After pouring out the test fluids, the composite test pieces were placed between two glass bars and pressed until there was no dripping or seeping out of excess test fluid. The composite test pieces were next placed between two glass plates and attached to a perspiration test machine, after which a pressure of 12.5 kPa was applied. The perspiration test machine in which the composite test pieces are installed in a vertical position was subsequently placed inside a dryer, where a temperature of 37±2°C was maintained for four hours. Thereafter, the composite test pieces were removed from the perspiration test machine and dried at 60°C or lower after separating the test pieces from the two standard adjacent fabrics. Determinations for discoloration of the test pieces were made in accordance with Section 9 (color fastness determination) of JIS L0801. The results are shown in Table 1.

Table 1

	Sample A	Sample B	Sample C	Sample D	Sample E	Sample F
Light resistance test (Level)	4-5	5 or more	4 or more	4	2-3	3
Perspiration resistance test (acidic) (Level)	5	5	5	5	2-3	3
Perspiration resistance test (alkaline) (Level)	5	5	5	5	2-3	3

[0043] As apparent from the results in Table 1, the samples E and F both only achieved levels of 2-3 and 3 in the light resistance test and perspiration resistance test, whereas the samples A, B, C, and D, which were fabrics according to the present invention, all obtained excellent results of level 4 or higher. In other words, this can be understood as the samples A, B, C, and D, which comprise silk yarn, wool yarn, or cotton yarn and nylon yarn containing an amount of titanium oxide as specified in the

present invention, being extremely effective in suppressing yellowing due to light or sweat. Moreover, despite using nylon yarn that is a chemical fiber, texture aspects of the samples A, B, C, and D such as appearance and feel against the skin are similar to cloth made from all silk yarn, wool yarn or cotton yarn.

(Test Example 2) Toxic Gas Adsorption and Sustained Release Tests

[0044] Variations over time in the toxic gas adsorption and residual properties of a cloth that is a fiber material according to the present invention were weighed against that for a cloth comprising only silk fiber.

Test Samples

[0045] Sample a: Circular knitted cloth that is a fiber material according to the present invention which was composed overall of 70% yarn comprising silk and 30% yarn comprising nylon fiber containing titanium oxide, and repeatedly worn and washed over one year was used.

[0046] Sample b: Unused circular knitted cloth that was 100% composed of yarn comprising silk.

[0047] Sample c: Cloth using cloth b that was repeatedly worn and washed over one year.

Test Methods

[0048] Toxic gas adsorption test: In order to make the samples a, b, and c adsorb toxic gas and measure the adsorbed amount, the samples a, b, and c are each placed into a pack made of synthetic resin. Each pack is then filled with toxic gas (formaldehyde, isovaleric acid, and ammonia) to a known control concentration. After three hours, the gas concentration in each pack is measured using a detecting tube. A value obtained by subtracting the concentration of gas remaining in the pack from the known control concentration was used as the adsorbed toxic gas concentration for each sample. The results are shown in Table 2. Note that the adsorption rate indicates the ratio of the various toxic gas concentrations adsorbed by each sample with respect to the control concentrations of the various toxic gases.

[0049] Toxic gas sustained release test: The samples a, b, and c with adsorbed toxic gas in the above toxic gas adsorption test were moved into tetrapacks (with a volume of 5 liters) in which air that does not contain formaldehyde, isovaleric acid, or ammonia is sealed. After three hours, the concentration of formaldehyde, isovaleric acid, and ammonia within the packs were each measured using a detecting tube. The results are shown in Table 3. Note that the sustained release rate indicates the ratio of

the amount released with respect to the adsorbed amount of the various toxic gases listed in Table 2.

Table 2

			Toxic gas concentration in pack after 3 hours (upper, ppm)		
Toxic gas	Initial concentra-tion	Control concentration once moved to vacuum pack	a	b	C
Formaldehyde	50	30	3.2	1.5	8.6
(Adsorption amount, ppm)			26.8	28.5	21.4
(Adsorption rate)			89.4%	95%	71.3%
Isovaleric acid	50	38	25.8	22.0	31.2
(Adsorption amount, ppm)			12.2	16.0	6.8
(Adsorption rate)			32	42	18
Ammonia (Adsorption	850	720	410	350	520
amount, ppm)			310	370	200
(Adsorption rate)			43%	51%	28%

5

Table 3

	Released amount and sustained release rate of toxic gas in pack (upper, ppm)		
Toxic gas	a	b	C
Formaldehyde			
(Released amount, ppm)	24.4	19.1	1.71
(Sustained release rate)	91%	67%	8%
Isovaleric acid			
(Released amount, ppm)	9.85	6.54	0.89
(Sustained release rate)	81%	41%	13%
Ammonia			
(Released amount, ppm)	244.58	242.35	24.19
(Sustained release rate)	79%	66%	12%

[0050] According to the results in Tables 2 and 3, a comparison of the toxic gas sustained release rate of cloth b comprising only silk fiber and the sustained release rate of sample c, which is the cloth that has been used for one year, shows that the values for sample c are drastically lower. On the contrary, although sample a being the fiber material according to the present invention that has been used for one year may not have a very low toxic gas adsorption rate, it still maintains an extremely high toxic gas sustained release rate with respect to the three types of toxic gas listed in Tables 2 and 3. Based upon such results, it is apparent that even after one year of use, the fiber material according to the present invention, sample a, is easily capable of releasing adsorbed toxic gas into an environment previously without such gas although toxic gas is adsorbed thereby. Namely, if an ammonia odor causing a strong odor in a bathroom or the like is adsorbed by clothes made from a cloth that is a fiber material of the present invention, the effect of the ammonia easily and quickly disappearing from the clothes in an environment outside the bathroom can be effectively continued even when using the clothes for one year. It therefore indicates that the effect of preventing residual odor of the strong ammonia odor on the clothes is effectively continued over a long period of time. With respect to the recent growing problem of illnesses related to a sick house, the fiber material according to the present invention can become effective material for clothes based upon its high sustained release rate for formaldehyde. Furthermore, it is also considered capable of effectively avoiding traces of an unpleasant odor due to sweat based upon the high sustained release rate for isovaleric acid. Hence, the fiber materials according to the present invention are capable of maintaining a high toxic gas sustained release rate over a long period of time, making them suitable as material for clothes.

(Test Example 3) Test for Measuring Warmth Retention Rate

[0051] Changes over time in the warmth retention characteristic of a cloth that is a fiber material according to the present invention were weighed against that for a cloth comprising only silk fiber.

Test Samples

[0052] Sample a: Circular knitted cloth that is a fiber material according to the present invention which was composed overall of 60% yarn comprising silk and 40% yarn comprising a nylon fiber containing titanium oxide, and repeatedly worn and washed over one year was used.

[0053] Sample b: Circular knitted cloth that is 100% composed of yarn comprising silk.

Test Method

[0054] The warmth retention rates of the obtained samples a and b were measured in accordance with a method in JIS L1018A (constant temperature method).

[0055] Test pieces measuring 30 cm × 30 cm were extracted at two locations from the obtained test samples a and b. Using a warmth retention test machine, the test pieces were attached to an isothermal heating element. Two hours after the heat flowing towards low-temperature outside air became constant and the surface temperature of the heating element indicated a constant value, heat passing from the test pieces was measured to find the heat lost to diffusion. The warmth retention rates (%) were then found based upon a comparison of this and the heat lost to diffusion over the same time under the same temperature difference in an empty state without the test pieces. Note that the test was performed twice, of which the average value was calculated and used for the results. Table 4 shows the results.

Table 4

	Warmth retention rate (%)
a	22.2
b	9.8

[0056] Prior to the tests, cloth a was presumed to have a warmth retention rate inferior to that of cloth b comprising only the silk fiber, because cloth a also used a nylon fiber, which is inferior to silk fiber in terms of warmth retention. Surprisingly, Table 4 shows that an extremely high result was obtained for the warmth retention rate of cloth a compared to that for cloth b, despite one year of use. Based upon such results, it can be presumed that cloth a has a high warmth retention characteristic when unused, and will continue to have a warmth retention characteristic after one year of use that is higher than that of cloth b comprising only the silk fiber. Therefore, the fiber material, which is a cloth according to the present invention, is capable of maintaining a warmth retention characteristic over a long period of time that is higher than a cloth comprising only silk. It is also possible to maintain warmth retention similar to that of a cloth comprising only silk even when structured as

thinner and lighter clothes, making such fiber material even more suitable as material for clothes.

(Text Example 4) Measurements of Breaking Strength and Elongation at Break

[0057] Changes over time in breaking strength and elongation at break of a cloth that is a fiber material according to the present invention were weighed against that for a cloth comprising only silk fiber.

Test Samples

[0058] Sample a: Unused circular knitted cloth that is a fiber material according to the present invention and composed overall of 70% yarn comprising silk and 30% yarn comprising a nylon fiber containing titanium oxide.

[0059] Sample b: Cloth using cloth a that has been repeatedly worn and washed over one year.

[0060] Sample c: Unused circular knitted cloth that is 100% composed of yarn comprising silk.

[0061] Sample d: Cloth using cloth c that has been repeatedly worn and washed over one year.

Test Methods

[0062] Tests were performed for measuring the breaking strength and elongation at break on each of the obtained samples a, b, c, and d. Note that the tests were commissioned to the IAA Center for Food Quality, Labeling and Consumer Services, and performed using a Tensilon II material testing machine under the conditions of 10 cm sample length, H.S 40 mm/min, and C.S 100 mm/min. The results are shown in Table 5.

Table 5

	Breaking strength (g/d)	Elongation at break (%)
a	3.46	14.3
b	2.47	10.8
c	3.254	15.1
d	0.493	3.2

[0063] According to Table 5, in the case of the samples comprising a cloth of the present invention, from unused (sample a) to one year of use (sample b), the breaking strength fell from 3.46 g/d to 2.47 g/d, and the elongation at break fell from 14.3% to

10.8%; results that indicate deteriorations in performance due to the passage of time were effectively suppressed. On the contrary, in the case of the sample comprising 100% silk cloth, from unused (sample c) to one year of use (sample d), the results show the breaking strength fell considerably from 3.254 g/d to 0.493 g/d, and the elongation at break also fell considerably from 15.1% to 3.2%. In other words, clothes comprising a cloth that is the fiber material according to the present invention are capable of maintaining their breaking strength and elongation at break performance over a long period of time. Even if thin, it is possible to maintain a strength similar to that of a cloth comprising only silk fiber, making such clothes even more suitable as lightweight clothing material.

INDUSTRIAL APPLICABILITY

[0064] Fiber materials (for example, yarns, knitted goods and woven goods) can be provided which sustain texture characteristics of a natural fiber such as silk, are effectively prevented from yellowing over time due to light or sweat, are less contaminated with a residual toxic gas, and are effectively prevented from worsening in warmth retention and strength over time, but which can be produced at a lower cost.